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ABSTRACT

A "Xenograde system" is an imaginary science system. As an imaginary science, it contains a set of concepts and principles which mimic many of the concepts and principles found in physics and other physical sciences. Xenograde is a highly complex closed system which simulates the movement of satellites orbiting a nucleus and some small particles called alphons contained inside the nucleus. The alphons and satellites follow a set of rules and "pseudoscientific" principles. The Xenograde rules themselves have no foundation in real-world science, but operate in much the same manner as real scientific principles; they are mathematically based, consistent, and predictable. The Xenograde system is complex enough to force students attempting to learn the system to use several different learning strategies. In addition, it provides a relatively content free or at least equalizing test bed for empirical research. Xenograde systems have been delivered by teachers with books, computer-controlled teacher machines, and computers in an effort to test instructional principles, cognitive abilities, cognitive styles, feedback, learner control, and rule-example versus discovery learning. (JN)

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XENOGRADE, THE IMAGINARY SCIENCE: A RESEARCHER'S UTILITY

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XENOGRADE: A RESEARCHER'S UTILITY

What is a "Xenograde System"? Xenograde systems (pronounced zen' -o-grade) is an imaginary science system. As an imaginary science, it contains a set of concepts and principles which mimic many of the concepts and principles found in physics and other physical sciences.

Xenograde is a highly complex closed system which simulates the movement of satellites orbiting a nucleus and some small particles called alphons contained inside the nucleus. The alphons and satelites follow a set of rules and "psuedo scientific" principles. The Xenograde rules themselves have no foundation in real-world science, but operate in much the same manner as real scientific principles, that is, they are mathematically based, consistent, and predictable.

Moreover, the Xenograde system is complex enough to force students attempting to learn the system to use several different learning strategies. A pioneer in the use of imaginary science, M.D. Merrill (1965) stated that, "In content and structure, this task (Xenograde) is almost identical to many scientific topics taught in school, and yet, because it is imaginary, it is extremely unlikely that any student will already know any of the content."

M. Merrill went on to analyze Xenograde in terms of Gagne's (1962, 1965) hierarchical structure. Figure 1 below indicates the results of Merrill's analysis. It is clear that Xenograde requires any student who hopes to master the system to learn terminology, facts, methodologies, conventions, and principles and to synthesize these into some kind of coherent whole. In general, the level of effort necessary for a student to learn Xenograde has been such that few, if any, students have learned it in one sitting.

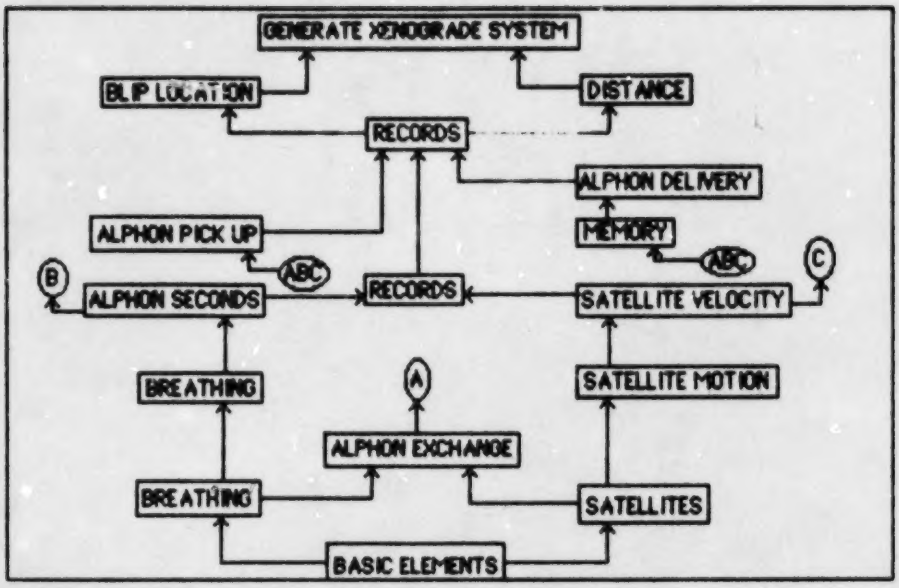

Fig. 1. Knowledge Hierarchy for Science of Xenograde Systems

The imaginary science system begins operation with its alphons, contained in the nucleus, and its satellites moving according to a set of prescribed principles. One such principle is the "breathing principle" which explains the moving of the alphons back and forth between the inner and outer shells of the nucleus. The various principles in Xenograde are often modified by seemingly random events, such as sattelites colliding. These events, in fact, can be predicted or the results of their having happened can be calculated and factored into the prediction model the student develops.

But why use Xenograde in research? There is a relatively straight-forward answer which centers squarely on the notion of "content free" learning and "content free" instructional principles.

Psychologists dream of getting truly novice subjects with which to do research, but reality dictates otherwise. The researcher is left with

subjects who have some, albeit limited, background knowledge of the particular content under study. The researcher resorts to controls and statistics in order to account for the unknowns which are often nothing more than prior knowledge. Moreover, the researcher will often try to choose a content area to which no subject has been previously exposed. Xenograde systems is such a content. However, it must be admitted that knowledge of game theory and/or strategy, general scientific principles, mathematics, problem solving skills and the like can definitely be helpful to students, but it is unlikely that any of these would be uniquely significant to a student attempting to learn Xenograde. Therefore, Xenograde provides a relatively content free or at le.. equalizing test bed for empirical research.

Given that Xenograde provides a content free test bed, who has used it and what have they used it for? Xenograde systems was created by Carl Bereiter in 1962 at the University of Illinois to test group interaction. Since then, a number of researchers have used variations of Xenograde in a variety of settings to test a variety of hypotheses.

One of the earliest research efforts was by M. David Merrill (1965) who investigated hierarchical summaries presented prior to problems, summary statements presented after problems, but relevant to the problem, and step by step problem solutions. Merrill used a computer based (IBM 1710) teaching machine system using an Autotutor and 35-millimeter rear-projection film capability to deliver Xenograde. M. Merrill (1966) further refined his conclusions in a series of studies using Xenograde that have contributed to the body of literature relating to the amount of time required and final learning outcome.

Paul Merrill (1970) investigated the effects of the availability of behavioral objectives on the general learning process. Specifically,

Merrill hypothesized that the availability of objectives would reduce the number of examples required and the amount of time needed to learn an imaginary (Xenograde) task. He found that, in general, objectives reduced the number of examples required, but did not reduce the total time.

Bunderson and Dunham (1970) examined the relationship between cognitive abilities and learning. Their goal was to "establish a theoretical and methodical continum from simple concept learning." Bunderson et al. (1971) later investigated individual differences as they related to discovery learning and rule-example learning. Oliver (1971), during that same period, investigated the role of sequencing of instruction and cognitive abilitiy variables using a computer delivered version of Xenograde systems. Hansen (1974) used a computer-assisted version of Xenograde to look at the effects of feedback, learner control, and cognitive abilities on anxiety. Burns (1980) investigated the lack of consistency in Aptitude-Treatment-Interaction research over time by using a series of bookiets and lectures to teach Xenograde systems to a group of high school students and Martin and Roberts (1982) used computer delivered xenograde lessons in an investigation of cognitive styles. Allen and Merrill examined "Cognitive Conscious Strategies" using a Xenograde based research tool. Finally, Eucher (1984) programmed and used a computer delivered version of Xenograde to conduct research on system assigned learning strategies.

In summary, Xenograde systems has been delivered by teachers with books, computer controlled teaching machines, and computers themselves in an effort to test instructional principles, cognitive abilities, cognitive styles, feedback, learner control, and rule-example verses discovery learning. In short, a tremendous variety of psychological and instructional variables have been successfully

investigated using the content free and highly taxing imaginary science called Xenograde systems.

What lies in the future? One of the more promising capabilities of computers is their ability to simulate things. Simulation can be used to effectively model certain procedures or environments. They can also be used to create environments that would otherwise be too expensive or hostile to the user; a plane crash or a nuclear chain reaction. Xenograde can be used as a vehicle to study student cognitive strategies vis-a-vis the manipulation of variables in an unknown or multi-tasking environment. It can also be used to study the kinds of feedback, guidance, and automation of skills in both general and specific content problem solving.

Imaginary science has been used for over twenty years to examine the basal or underlying instructional and learning principles which cut across content and tasks. Computer simulations are essentially yet another area where the use of Xenograde or a computerized version of the program has, and will continue to make, a major contribution to the literature.

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